ACTIVELY CONTROLLED TEXTURING SYSTEMS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] The present application claims priority to and continues in part from U.S. application Ser. No. 12/761,709 entitled "ASSEMBLY FOR AND METHOD OF FORMING LOCALIZED SURFACE WRINKLES" and filed on Apr. 16, 2010, the entire scope of which is hereby incorporated by reference.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The present disclosure generally relates to systems for and methods of producing surface wrinkles. More particularly, the invention pertains to a system for and method of actively producing surface wrinkles using active material actuation, and more applicably, shape memory alloy and shape memory polymer activation.

[0004] 2. Discussion of Prior Art

[0005] Surface wrinkles have been used to effect, modify, or control various benefits/conditions, including surface adhesion, reflection, texturing, coefficients of friction, structural colors, metrology, and haptic alerts. Methods of producing surface wrinkles preexisting in the art include using a stretched substrate overlaid by a rigid (e.g., metal) overlay. Wrinkles are instantaneously or selectively produced in the overlay, upon the release of energy by the substrate, if the compressive strain in the overlay exceeds the critical bucking strain. As a result, these conventional methods produce generalized wrinkles that co-extend with the entire surface defined by the overlay. This method is in fact behind wrinkles commonly encountered, for example, on human skin and dehydrated apples. Of particular interest is that the wrinkle geometry is closely related to the material properties. Precisely controlled wrinkle structures have found many interesting applications including nano-metrology, stretchable electronics, biosensors, and manipulation of material topographic properties.

BRIEF SUMMARY OF THE INVENTION

[0006] The present invention recites a novel system for and method of actively producing wrinkles within a surface, and more specifically, to a system for and method of producing surface wrinkles utilizing active material actuation. The present invention is useful for modifying the surface texture, and/or coefficient of friction of a continuous surface, so as to modify a physical interaction with the surface. The physical interaction may be reflective, thermal, fluidic, electro-magnetic, tactile, acoustic, emissive, or simply visual or aesthetic.

[0007] The benefits of active surface textures can be realized across many applications, and may interact with different physical phenomena over a broad range of texture changes. The wavelength modification may be on the order of microns in one application and centimeters for another (diffraction and friction, respectively) or larger (aesthetics). In a specific example, the present invention may be used to modify the roughness of a vehicular surface, such as the dashboard, so as to diffuse veiling glare caused by the sun or oncoming traffic, and thereby reduce driver eye fatigue. This will allow lighter colored materials to be utilized (giving the interior cabin a more spacious appearance), without detriment to visibility. In other automotive applications, the present invention is useful for modifying skid resistance, slip resistance, and the overall slipperiness of surfaces such as of running boards, floors of cargo areas, seats, horizontal surfaces in general and walls of storage areas such as cup holders, reducing (or increasing) RADAR scatter on electrically conductive surfaces, mitigating acoustic noise, such as wind noise, modifying airflow over surfaces and thus aerodynamic drag, and increasing (or reducing) emissivity and convective/conductive heat transfer rates of a surface, such as a steering wheel surface.

[0008] In general, the invention presents a system for selectively forming wrinkles, or modifying the amplitude, wavelength, and/or pattern of existing wrinkles upon a surface. The system includes a reconfigurable substrate presenting a first elastic modulus and Poisson's ratio, and an overlay that defines the surface, is adhered to the substrate, and presents a second elastic modulus or Poisson's ratio greater than the first. The system further includes at least one active material element operable to undergo a reversible change in fundamental property when exposed to or occluded from an activation signal. The element(s) is communicatively coupled to the overlay, and is configured such that the change causes the substrate to reconfigure and the wrinkles to form or modify upon the surface as a result thereof.

[0009] The disclosure may be understood more readily by reference to the following detailed description of the various features of the disclosure and the examples included therein.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWING

[0010] A preferred embodiment(s) of the invention is described in detail below with reference to the attached drawing figures of exemplary scale, wherein:

[0011] FIG. **1** is a perspective view of the interior cabin of a vehicle, particularly illustrating a controlled texturing system including wrinkled overlays composing the dashboard, and center console, and a shape memory wire mesh, in accordance with a preferred embodiment of the invention;

[0012] FIG. **2** is a plan view of an actively controlled texturing system including an overlay defining axially produced surface wrinkles, and further including a shape memory wire actuator, a sensor, a power supply, and a controller communicatively coupled to the actuator, sensor, and supply, in accordance with a preferred embodiment of the invention;

[0013] FIG. **3** is a plan view of an overlay surface defining bi-axially produced surface wrinkles, and plurality of shape memory wires, wherein the wires present a mesh configuration, in accordance with a preferred embodiment of the invention;

[0014] FIG. **4** is a cross-section of an actively controlled texturing system including an overlay defining a flat pre-activation surface, a substrate adhered to the overlay, a shape memory wire actuator embedded within the substrate fixedly secured to end caps oppositely engaging the substrate, in accordance with a preferred embodiment of the invention;

[0015] FIG. **4***a* is a partial plan view of an actively controlled texturing system having radially extending wires and defining a radial wrinkle pattern, in accordance with a preferred embodiment of the invention;

[0016] FIG. **5** is a cross-section of an actively controlled texturing system including an overlay defining surface wrinkles (in enlarged caption view), a substrate adhered to the overlay, a shape memory wire actuator external to the sub-